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generally to substitute "symmetrical" for the "equal" which is found in most books or for the "congruent" found in some.

Theorem 58. *The bisector of the vertical angle of an isosceles triangle, the perpendicular bisector of the base, and the perpendicular let fall from the vertex to the base are all coincident.*

Theorem 59. *In a triangle symmetrical angles are opposite congruent sides and conversely. In case the angles are not symmetrical the greater angle is opposite the greater side and conversely.*

Theorem 60. *Of oblique lines drawn from a point to a line those cutting off the greater segments from the foot of the perpendicular are the greater or the less according as the perpendicular is less or greater than a quadrant.*

To quote the theorems concerning the locus of points equidistant from two given points or from two given lines and others like them would be merely tedious. Enough has been said to show the great importance of the ideas of symmetry to the development of spherical geometry and of plane geometry in case all operations are to be restricted to a plane. The really instructive part of the work was the necessity of establishing the existence of such objects as symmetrical triangles. It may be noted that as yet no construction for the middle point of a line or for the bisector of an angle or for a right angle has been given. These come in more appropriately under the topic of circles. The knowledge of the existence of the elements desired and not a method of finding them has been all that has proved necessary. It may also be noted that no measure either of segments or of angles has been introduced. The ideas of congruence, of "greater than" and "less than" which were derived from congruence, and even of the sum of two segments could all be carried out in a purely geometrical way by aid of Axiom V with no assistance from the theory of number.

# A SIMPLE CONSTRUCTION FOR FINDING THE DIAMETER OF A GIVEN MATERIAL SPHERE.

By H. S. QUACKENBUSH, Lawrence Scientific School, Harvard University.

The following construction for finding the diameter of a given material sphere appears simpler and more direct than the one given in Wentworth's, Phillips and Fisher's, and other current text-books.

From any two points $P$ and $Q$ on the sphere as poles, with compass-opening $a$, describe two arcs on the sphere, intersecting at $A$ and $B$. From the same two points as poles, with a different compass-opening $b$, describe two more arcs, intersecting at $C$ and $D$. These four points, $A$, $B$, $C$, $D$, will then lie on a great circle of the sphere, namely, the perpendicular bisector of the arc $PQ$.

To find the diameter of the sphere we have then simply to choose any three of these four points, say $A$, $B$, $C$, measure with the compasses the straight line distances between them, lay off the plane triangle $ABC$, and find the diameter of its circumscribed circle.

This construction, like the one usually given, requires only a small part of the spherical surface to be accessible. A good check on the accuracy of the work can be obtained by making a different choice of the three points.